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The Interest Rate and the Length of Production: A Comment¹

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Abstract: Machaj (2015) does a great service in pointing out a key assumption, heretofore unaddressed, in Filleule (2007) and Hülsmann (2010). Machaj errs, however, in stating that *who* saves will have an ambiguous effect on the interest rate and that *where* savings are directed can have ambiguous effects on the length of production. In this brief comment I will first show that who saves will have no effect on the interest rate. I then turn my attention to what it means to “lengthen” the structure of production. Although extended production time or additional “stages” of production make convenient placeholders for increased roundaboutness, they fail to grasp the core concept as it pertains to capital theory – what is it about production processes that makes more or better consumer goods?

Keywords: capital theory, interest, production structure, roundaboutness, labor intensity

JEL Classification: B13, B53, D24, E43

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The Interest Rate and the Length of Production: A Comment

What is the relationship between the rate of interest and the structure of production? Austrian-school economists often claim an unambiguous negative relationship between these two variables. Indeed the assertion that artificial reductions to the interest rate cause an unsustainable lengthening in the structure of production is the central tenet of the Austrian theory of the business cycle.

Recently, Fillieule (2007) and Hülsmann (2010) have challenged this claim by deriving the logical outcome of a drop in the interest rate given a fixed stream of aggregate expenditure. As the rate of interest falls, current consumption is discounted at a lower rate. The result is a shorter production structure, with production activities moved closer to final consumption, or to what Menger (1871: chap. 1) referred to goods of the first order. While such an outcome is opposed to traditional analysis, it is the logical consequence of a reduced interest rate on a constant expenditure stream.

While such reasoning is correct, bypassing an important causal relationship creates an outcome more apparent than real. Within a fixed expenditure stream, the interest rate can only decrease if consumption falls or savings increase. Both of these outcomes represent different sides of the same coin, as the market rate of interest is the intertemporal price differential between present and future goods, i.e., between consumption and investment expenditures.² Machaj (2015: 279) is quite correct in challenging Fillieule's and Hülsmann's novel conclusion that a lower interest

² Technically the pure rate of interest is the intertemporal price differential between equivalent satisfactions, as provided for by the use values embodied in goods. To the extent that financial assets, such as money, circulate according to their exchange and not use value (Howden 2015: 17; 2016a), the intertemporal price differential of the physical goods will be the same as that of their satisfactions.

rate will shorten the structure of production since they give no cause as to why the interest rate would fall. Realizing that a decrease in the level of consumption is a necessary precondition for a falling interest rate goes far in illustrating the traditional negative relationship between the interest rate and the length of production.

Machaj overreaches with this conclusion, however, in then positing that *who* increases his savings will have an ambiguous effect on the interest rate. He does so by describing scenarios where the interest rate decreases without decreases in total consumption. This outcome gives the seeming result of “total savings increasing without total consumption going down” (Machaj 2015: 279).

Imagine a simple scenario of capitalists decreasing their consumption by X units (total savings increase). Imagine that this additionally saved money is being spent only on higher wages. Under the framework—for the purpose of simplicity—workers are being treated as pure consumers, so that wages are fully spent on consumption. Hence a decrease in capitalists’ consumption by X units is fully (under such scenario) counterbalanced by an increase in X units of laborers’ consumption. At the same time, total savings are increased (because capitalists are saving more), and the interest rate can fall with total consumption unaltered. (Machaj 2015: 279-80)

The belief that *who* does the saving – lower time preference capitalists or higher time preference workers – is attractive but misplaced. What matters is the aggregate level of savings and not its composition amongst individuals.³

³ Indeed, the stock of savings has only a value dimension and does not acquire a temporal aspect until it is invested (Braun 2014: 55)

Assume a closed economy in a no-profit equilibrium. Aggregate income Y accrues to factor owners in the following manner (Rothbard 1962: 334): workers in the form of wages w , capitalists in the form of a return r on their investment, and landowners by payments l for the use of land. Workers consume C_W , capitalists consume C_K , and landowners consume C_L , with total consumption C being the sum of worker, capitalist and landowner consumption. There is no income hoarded in the form of money.

Workers' savings S_W are given as:

$$S_W = w - C_W$$

Capitalist savings S_K are given as:

$$S_K = r - C_K$$

And landowners' savings S_L are given as:

$$S_L = l - C_L$$

Since savings in the closed economy can only come from workers, capitalists and landowners, total savings S simplifies to the standard expression:

$$S = Y - C$$

Since the interest rate is negatively related to the savings-consumption ratio, and since aggregate savings and aggregate consumption are two sides of the same coin, we find the standard result that increases in consumption must drive savings lower and thus increase the rate of interest.

In this scenario, all income flows to the factor owners in the form of wages, a return on capital and rental payments for land use, and these groups then decide whether to save or consume this income according to their own preferences. Taken together it is clear that aggregate savings

cannot increase except by either 1) an increase in income, or 2) a decrease in aggregate consumption expenditures. The composition of the originators of the savings, however, has no bearing on the rate of interest.

Machaj's example aims to show that savings can decrease even if total consumption is unchanged. Since he assumes explicitly that the expenditure stream Y is constant, the inconsistency between a falling interest rate with unchanged consumption must be explained through other means. Machaj assumes the worker is a pure consumer with no savings ($C_W = w$). He then proceeds to shift the income distribution so that r increases by the same amount as w decreases. It is here that he states that savings must rise since workers save less than capitalists. However, the total sum of consumption expenditures will also have decreased by the same amount and not remain constant as Machaj states.

To summarize, the redistribution of income will decrease consumption by the same amount as savings have increased, resulting in a lower interest rate. Consequently, Machaj has not demonstrated that a decline in saving need not be offset by a commensurate increase in consumption expenditures.⁴

Still, the second part of Machaj's paper focusing on intertemporal labor intensity (ILI) has great merit though not because it pertains to the consumption-savings relationship. Instead, it helps to answer the question of "*where does the saved money go?*" (Machaj 2015: 280). This question has heretofore been answered in peculiar ways, e.g., Fillieule (2007) sees any change in savings as

⁴ Before moving on I must point out one more quibble with Machaj's presentation of the relationship between the length of the structure of production and changes of the consumption-savings ratio. He (2015: 279) points out correctly that what is relevant is the interest-rate elasticity to the consumption-savings ratio, though comments that a sufficiently high elasticity would shorten the structure of production. Actually, the sign on the elasticity is the only relevant determinant of whether the structure of production shortens, lengthens or is neutral with respect to changes in the consumption-savings ratio. As we will see, the answer to this question hinges critically on what one means by changes to the "length" of the structure of production.

being distributed evenly across the stages of production, and Hülsmann (2010) assumes all savings are directed to the first stage of production. Machaj's contribution is in relaxing these assumptions.

Machaj gives a series of three examples where a lowering of the equilibrium rate of interest induces either no change, a lengthening or a shortening of the number of stages of production. All three examples share a common interest rate and the only differentiating factor is the ILI. The ILI is the degree to which labor is employed in production and, more importantly, where within the production process this takes place. Machaj's examples illustrate that labor employed at the later stages of production will have the intuitive (and standard) effect of lengthening the structure of production. If however capitalists employ laborers at the earlier stages of production the result will be a reduction in the number of stages of production.

Machaj uses this insight to question Hülsmann's central conclusion – that a shortening of the production structure will result from a lower interest rate. Effectively Machaj demonstrates that this result has nothing to do with the rate of interest but rather depends on where labor expenditures are directed.

Machaj sheds light on what Howden and Yang (2016; forthcoming) refer to as the “structure of labor” by which they mean the temporal and qualitative ordering of labor that complements capital along the structure of production. Superficially one could believe that Machaj's example relies on an adequate answer to whether human capital is indeed capital in the same sense that physical capital is. I claim only a “superficial” relevance to that question since the labor/capital ratio of 85/200 is constant in all of his examples and thus the relationship between the length of the production structure must be contingent on some factor other than the relationship between any definition of human capital and physical capital. Freed from commenting on controversies

concerning the quality of labor, I will point out two deficiencies with the problem as it is structured.

The first is that, as in Fillicule (2007) and Hülsmann (2010), Machaj has no causal explanation for why the interest rate falls. The interest rate decreases from an equilibrium level of $1/9$ to $1/19$ in all three of Machaj's examples, though this is not caused by a change in the consumption-savings ratio, which remains constant at $1/2$. Nor does a change to the money supply or its velocity affect the interest rate, as the expenditure stream (MV) is fixed at 300 in all examples. Given no causal reason to explain why the interest rate was more than halved, it is difficult to treat Machaj's conclusion as anything more than a theoretical example of passing curiosity, but which has no bearing on the real world.

More seriously, attempts to show paradoxical changes in the production structure due to changes in the interest rate without giving a reason why the rate changed are analogous to reasoning from a price change. Although they represent seemingly plausible and logically consistent examples, they lead to vacuous results. To give an analogy, the physicist could, e.g., wonder what the effect would be on a 120-mile journey that takes two hours at 60 miles per hour if we increased the speed to 90 miles an hour. If our travel time remained constant it would be obvious the distance magically lengthened to 180 miles. Of course, the correct answer would lie in identifying that travel time is the result of speed and distance, notwithstanding that the three variables are all defined tautologically in terms of each other. The journey cannot take on multiple lengths, and the time must change to equate the new speed with the existing distance.

Likewise, attempts to derive changes to the length of production when the interest rate changes and the consumption-savings ratio and aggregate level of expenditure remain constant suffer the same deficiency. The rate of interest is not *sui generis*. It is determined first and foremost by the

savings-consumption ratio. Thus the interest rate is the dependent variable that changes in response to the savings-consumption ratio and cannot be treated as the independent variable affecting savings or consumption.

Still, we can let this objection pass and question whether there is something else in his result of interest. Implicit in the statement that the structure of production changes length according to changes in the interest rate, or dependent on the degree of ILI for that matter, is that we share a common understanding of what units the production structure is measured in. Machaj uses two units interchangeably. On the one hand the production structure is reckoned in “stages” and to lengthen the structure means to add a new stage. On the other hand each stage is defined as having a duration of one year. To lengthen the structure thus implies a greater amount of temporal units necessary to produce a given amount of output.

Such beliefs about how best to measure the structure of production are common. Fillieule (2007: 201) makes the same assumption, as does Hülsmann (2010). The use of “stages” is deficient, however, in that adding more stages is analogous to a lengthened production structure but gives no reference to whether the stage is added closer or further from consumption. In other words, the temporal ordering of stages does not affect the length of the production structure, provided that somewhere in the structure there is productive activity.⁵

If stages or time are deficient units, when the Austrian-school economist refers to the “length” of the structure of production, in what units must he measure this dimension? Although increased production time is the conventional usage of the term “lengthening”, there are good reasons to doubt its applicability.

⁵ One could quibble that defining each stages as a fixed temporal length, e.g., one year, is ad hoc though as an assumption there is nothing unmeritorious about doing so.

The most obvious doubt should come from the apparent, if contrived, examples that show an ambiguous relationship between the rate of interest and the temporal length of the capital structure. One of Machaj's great contributions is in demonstrating that where savings, signaled as they are by a lower interest rate, are invested is more complicated a question than was once thought. Of course we know that savings will be directed more profitably at a temporal stage further from final consumption as the interest rate falls due to the discount effect. At the same time if, as is the case in an Austrian business cycle, consumers increase their demand for consumption goods, entrepreneurs will be enticed to invest resources closer to final output to take advantage of the derived demand at these lower stages. Garrison (2001: 72) refers to the "tug-of-war" that occurs at both ends of the structure of production, but doesn't have a clear way to answer whether the strain at the higher and lower stages is "lengthening" the production structure.

Results that show an ambiguous relationship between the length of the production structure and the interest rate do so by defining the length in terms of "stages", or what is analogous, time. There is great ambiguity in the Austrian literature as to what a "lengthening" of the structure actually means. Examples abound of the lengthening being the addition of more stages (e.g., Garrison 2001: 82; Rothbard 1962: 519, 996; Huerta de Soto 2006: 280; Hayek 1935: 156).⁶ Other authors stress the lengthening of the time element of production (Böhm-Bawerk 1889: 82; Strigl 1934: 3-4; Rothbard 1962: 423; Reisman 1990: 460; Mises 1912: 360; 1949: 556; Hayek 1935: 150).

⁶ Of these authors only Hayek (1941: 73) has paid attention to defining what a "stage" of production actually means: separate operations performed by distinct firms. I doubt this definition is readily shared by others using the concept.

Both views on lengthening are consistent with the approach used by Machaj, which he uses to illustrate his counter-intuitive result. One could also point to more nuanced views that *could* be consistent with Machaj's examples of a lengthened structure of production. Rothbard (1962: 1006fn113; 1963: 10), Huerta de Soto (2006: 337, 365, 369), and Hayek (1935: 310) all allude to the weighting of investment according to what stage it is directed to. Under this chain of thought it is possible to conceptualize an investment made in a higher stage as lengthening the structure of production more than an equivalent investment in a lower stage since the investment is further from final consumption.

Equating additional stages, with a lengthened period of production is not without its drawbacks. Böhm-Bawerk (1889: 82) first noted that there was no strict proportionality between the number of stages and the length of production time, and Hayek developed this chain of reasoning more fully (Hayek 1941: 73-74). In a section devoted to "Capital Accumulation and the Length of the Structure of Production", Rothbard gives an example where there is an ambiguous relationship between Robinson Crusoe's investments, total consumable output produced and the temporal period of production of this output (1962: 543). Hayek gives the most comprehensive examination of this point:

It is frequently supposed that all increases in the quantity of capital per head (at least when they do not involve changes in the quantities of durable goods) must mean that some commodities will now be produced by longer processes than before. But so long as the processes used in different industries are of different lengths, this is by no means a necessary consequence of a change in the investment periods of particular units of input. If input is transferred from industries using shorter processes to industries using longer processes, there will be no change in the length of the period of production in any

industry, nor any change in the methods of production of any particular commodity, but merely an increase in the periods for which particular units of input are invested. The significance of these changes in the investment periods of particular units of input will, however, be exactly the same as it would be if they were the consequence of a change in the length of particular processes of production. (Hayek 1941: 77-78)

Machaj relies on labor reallocations to show scenarios in which the structure of production is temporally lengthened or shortened given the same interest rate, but Hayek was critical of any approach to understanding the lengthening of the structure of production by means of looking at shifts in labor instead of capital (1936: 496, fn16). This stemmed from his belief that focusing narrowly on labor shifts would not explain why an increase in that specific factor was being pursued, something which he believed could take place only after a capital investment had increased the marginal productivity of labor. Thus the term “period of production” (including capital *and* labor) was an unfortunate term to describe the intended phenomenon, i.e., more roundabout production processes. (One alternative offered by Hayek was to measure roundaboutness by way of the “period of investment” (Hayek 1936: 496).)

By providing multiple production structures differing only by the stages at which payments to an originary factor are made and in what magnitude, Machaj gives no explanation for why the rearrangement of the structure of production should occur. Capitalists will not rearrange deliberately the input factors along the structure of production unless the consequence is greater productivity or decreased costs. In Machaj’s examples the total amount of expenditure directed to labor relative to aggregate expenditures (actually to the originary factors in general, but he focuses on labor) increases from 70/300 to 85/300. This bidding for labor, either in terms of

higher wages or more workers, only occurs if labor productivity is enhanced. The only way for labor productivity to increase is by increasing the capital stock per worker. Note that this final point is not just an empirical tendency, but rather a praxeological law. Contriving examples to illustrate where labor will be reallocated to within the production structure without making reference to the reasons *why* labor will command a higher wage or be demanded in greater quantities are technical questions that do not fall within the scope of economic theory. Any consequent discussion of changes to the length of the structure of production that starts by assuming away the reasons why the length would change provide answers to questions that do not concern the economic theorist.⁷

If lengthening the structure of production has any relevance for capital theory, it is only as a placeholder for roundaboutness. After all, it was the more roundabout methods of production that Böhm-Bawerk stressed as the cause of economic growth (1889: 10-15). (Economic growth is here understood to mean more or better consumers goods.) A greater amount or more highly valued output could be produced for a given amount of inputs only if the inputs were arranged in such a way that coincided with more capital intensive means of production.⁸ In this way roundabout production processes are those that are more capital intensive. Consequently, when the Austrian-school economist discusses lengthening the structure of production he must not entertain notions that it is a temporal extension (although it could be). Nor must he consider the addition of more stages or operations in the productive process (although this too will likely occur). Instead he must reckon lengthening in physical terms – an increase in the capital intensity of the production process.

⁷ I thank an astute referee for this point.

⁸ I ignore here technological advances.

That conclusion only pushes the problem one step further back: what is the best measure of capital intensity? There are only two ways that the production structure could be said to become more capital intensive (Howden 2016b; c). The first is through the production of a greater amount of durable capital goods. Thus if the output mix between capital goods and consumption goods shifted in favor of the former, the result would be a greater intensity of the capital stock.⁹ This increase in capital intensity of the overall production process can be achieved by 1) substituting more capital-intensive production processes for shorter labor-intensive processes, 2) shifting production to existing goods that entail a more capital-intensive production process, 3) producing new goods in a capital-intensive way without changing the production plans of existing goods, or 4) increasing production of existing goods in less capital-intensive industries (e.g., oranges) while not retrenching production of goods in more capital-intensive industries (e.g., heavy machinery). All of these examples increase the capital intensity of the structure of production, and in a roundabout way they will also result in temporally lengthened production processes since the capital goods themselves embody not just the originary factors of production, but also “time stored up” (Mises 1949: 492). Furthermore, method 4 would result in an increase in the ratio of temporally shorter to longer production processes but would still require additional capital, which is consistent with the goal of increasing the roundaboutness of a production process.

The depreciable nature of durable capital goods leads us to the second method to increase the capital intensity of the production structure. Production of more durable capital implies that less future output will be needed to keep the existing stock intact. Thus, capital intensity can be

⁹ This is subject to a minimum threshold. Capital suffers depreciation and a portion of the newly produced capital goods in any given period will be necessary to replace the lost productivity of the existing stock. Thus, the structure of production can only be said to become more capital intensive if a sufficient amount of capital goods are produced to replenish the depreciation of the existing stock.

increased if the durability of the newly produced capital goods is greater than previously was the case.

While these two definitions of increased roundaboutness concern the production of capital exclusively there is also a third, less explored, way. Roundaboutness is undertaken to produce more or better consumer goods. If the average duration of serviceableness, i.e., durability, of such goods were increased with no change in the aggregate production methods, one could still say an increase in roundaboutness had occurred. Böhm-Bawerk (1888: 89-94) discusses this outcome though is hesitant to include changes to the durability of consumer goods as a type of roundaboutness in production, but rather as a “parallel” process that augments the phenomenon.¹⁰

Machaj abstracts from the output mix in his examples, and thus we cannot be sure whether any of them represent a lengthened structure of production, notwithstanding the appearance that this has happened by focusing on the temporal aspect of production. In conclusion, changes to savings preferences alter the “length” of the structure of production, which is reflected in the interest rate. In the unhampered economy, the interest rate does not change the structure of production but rather it is through preference shifts between present and future goods on the structure of production in conjunction with the credit market that the interest rate obtains. Of course, the role of the production structure in determining the rate of interest on the loan market has been discussed already and at length in Rothbard (1962: chap. 6 and esp. 378).

¹⁰ I have noted elsewhere the relationship between the durability of consumer goods and the term structure of interest (Howden forthcoming), but Böhm-Bawerk focuses here on the relationship between the durability of consumer goods and the demand for future goods, which then affects the pure rate of interest.

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